Energy Handbooks for Planners

Executive Summary

Ontario Ministry of Energy
Honourable Philip Andrewes Minister
Energy Ontario

ISBN 0-7743-8437-9
1.5M/9/83/396

Ontario

Energy Ontario

Deputy Minister

Ministry of Energy

Queen's Park
Toronto, Ontario
M7A 2B7
416/965-4565
Telex 06217880

July 14, 1983

Dear Reader,

Under the new Planning Act, the Provincial government has identified energy considerations as an element of provincial interest in municipal planning and development.

One obstacle to the incorporation of energy considerations in land use planning has been the absence of clear guidelines explaining the various techniques and approaches. The information that has been available is sometimes difficult to obtain, and may not be applicable in Ontario.

The Ministry of Energy has commissioned the production of a series of ten handbooks to help overcome this obstacle, and they are described briefly in this summary document. The handbooks cover a wide range of energy issues as they relate to planning and development in Ontario. This summary document is designed to provide the reader with a brief introduction to each of the ten handbooks.

It is hoped that the information in the handbooks will result in community developments which are viable and attractive and reflect energy concerns in their design. I am sure that this will help in reaching Ontario's energy security targets.

For information on how to obtain copies of these handbooks, please call 965-3246 (in Toronto). Outside Toronto, call the Operator and ask for Zenith 80420.

Yours truly,

Glenn R. Thompson
Deputy Minister

Energy Handbooks for Planners

Many municipalities in Ontario have undertaken measures to improve their energy efficiency. One of the more challenging measures is the practice of energy management through municipal land use planning and development.

There has been an increasing amount of literature available on various energy conserving measures in land use planning. However, application of these measures by planners, engineers and other municipal officials has been limited. Attention has focused on the general concepts of energy-conserving land use planning, but efforts to apply these concepts have been hindered by a lack of practical techniques and illustrations which the planner can apply to his or her local circumstances.

The Energy Handbooks for Planners provide a number of methods and techniques for developing policies and strategies for energy-conserving land use planning. The series also includes supporting information such as definitions of energy terms, and climatic information for energy-conscious planning.

There are ten volumes in this series. Each volume is discussed in greater detail on the following pages. Comments from interested readers are invited and should be sent to:

Energy Conservation Branch
Ontario Ministry of Energy
56 Wellesley Street West
10th Floor
Toronto, Ontario
M7A 2B7

The Ministry of Energy's Handbooks for Planners

Glossary of Energy Terms for Planners

Solar Energy and Land Use

Solar Zoning Techniques

Energy and Rural Land Use Planning in Ontario

Landscape Planning for Energy Efficiency

Climatic Information for Energy Conscious Planning

The Community Energy Profile: Concepts, Methods, Applications

Guide to Community Energy Profiling

Estimating Energy Consumption for New Development

Alternate Energy Supplies and Technologies and their Implications on Land Use Planning

Glossary of Energy Terms for Planners

This **Glossary of Energy Terms for Planners** is intended to be an aid to municipal officials and others involved in energy-related planning. The terms included have been selected to serve two purposes:

- to help the planner in his/her day-to-day professional responsibilities, as they touch on energy; and
- to help the planner become more familiar with, and conversant in, the energy terms, issues, and options that touch our daily lives.

The **Glossary** is divided into three parts.

- PART I contains selected *abbreviations* that may be encountered by the municipal planner, together with their full written forms (e.g., CNG = compressed natural gas). The *meaning* of these individual terms is not specified; if they require explanation, they are included in Part II.
- PART II is the actual *glossary.* The terms included cover a wide range of topics that are related to energy. Very familiar terms and self-explanatory terms are not included, nor are planning terms that do not relate directly to energy.
- PART III contains *conversion tables* that, for instance, can assist in metric conversion and give an indication of the energy content of selected Canadian fuels. The most important units included in the tables are also defined in Part II.

Solar Energy and Land Use

The purpose of this report is to provide municipal planners in Ontario with an understanding of solar energy, how it is being utilized in buildings and industries, technologies and processes currently available, and how it may be utilized in the future. The report discusses effects that solar technologies may have on building design and land use and responses that could be developed in the area of land use planning and development controls to accommodate these technologies.

Chapter 1 discusses the essential characteristics of solar energy, how it can be utilized, and the basic components of a solar energy utilization system. In Chapter 2, the three processes for converting solar radiation into useful energy are discussed in detail: solar thermal (passive and active systems), solar electrical, and solar chemical processes, together with applications, case studies, and cost-effectiveness (particularly for solar thermal processes, the most developed of the three).

Chapter 3 concentrates on the application of solar thermal systems for space heating and hot water heating to different building types. This is summarized in a table (see following page), of the applicability of solar energy to these building types in Ontario. Chapter 4 discusses the land use impacts of accommodating solar systems in built-up and new development areas for each land use/building type. Chapter 5 concludes by outlining in general terms, the legislative and other tools available to planners in Ontario for protecting solar access.

Applicability of Solar Energy to Building Types in Ontario

	DEMANDS			SYSTEM APPLICABILITY			COMMENTS
	Space Conditioning		Hot Water	Space Conditioning		Hot Water Active	(Where * Noted)
	Heat	Cool		Passive	Active		
3.1 Residential							
a) Single Family Detached	○		○	○	○	○	
b) Attached Multiple	○		○	○	○	○	
c) Low Rise Apartments	○		○		○	○	
d) High Rise Apartments	○		○		○*	○*	Site or roof area may not be large enough for collectors
3.2 Industrial							
a) Low Rise Industrial	○		○	○	○	○	
b) Specialized Industrial		○	○	doesn't apply	○	○*	Use of waste heat may be cheaper
3.3 Commercial							
a) Low - Medium Rise Offices		○	○ low	doesn't apply		○	
b) High Rise Offices			○ low	doesn't apply		○*	Probably insufficient roof area
c) Hotels	○	○	○			○*	Use of waste heat may be cheaper
3.4 Retail							
a) Shopping Centres		○	○ low	doesn't apply		○*	Low water demand
b) Single Use Buildings		○	○	doesn't apply		○	
3.5 Public							
a) Hospitals	○	○	○ high	doesn't apply	○	○*	High water demand
b) Schools	○	○	○	○	○	○	
c) Assembly		○		doesn't apply			
d) Other	○	○	○ low	○	○	○	
3.6 Other Types							
a) Mixed Use Complexes		○	○			○*	Use of waste heat may be cheaper

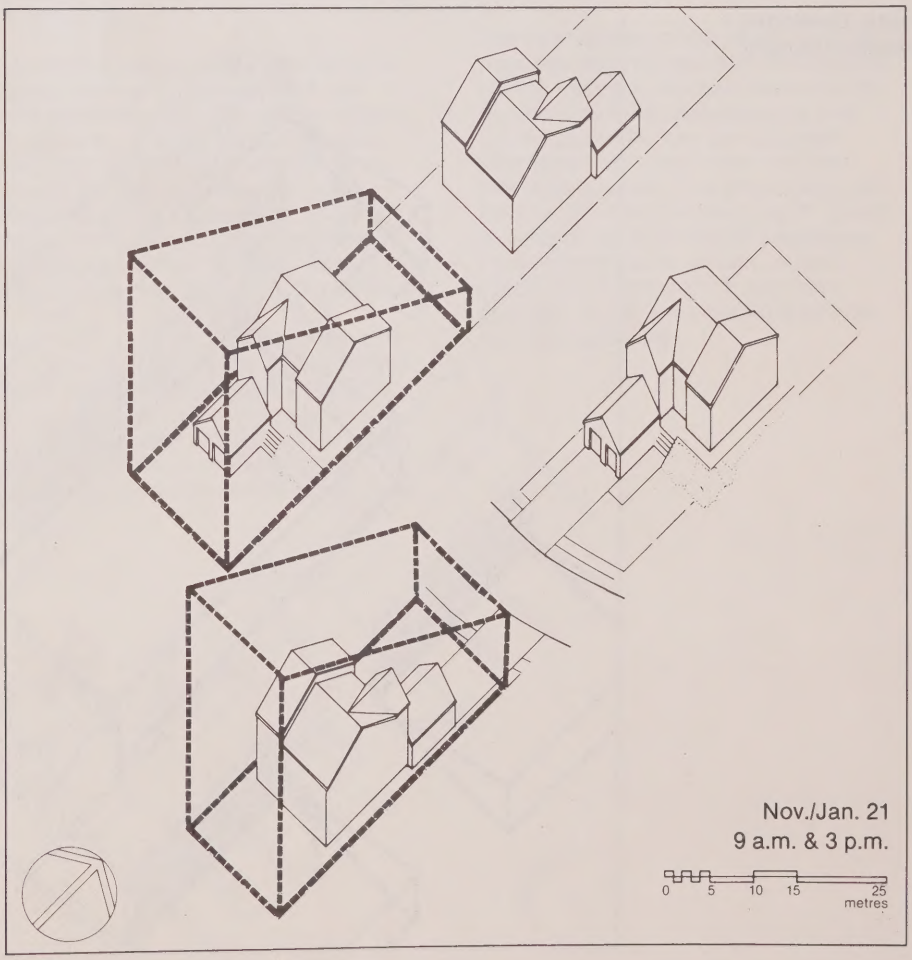
Solar Zoning Techniques

The Province of Ontario has adopted an overall Provincial energy policy which includes a solar energy target of 2% of Ontario's energy needs to be provided from solar energy by 1995, or the equivalent of space heating for more than 700,000 Ontario homes per year. Achieving this target will require a significant recognition by Ontario municipalities of the importance of land use planning for both active and passive solar systems. One of the most important elements in such local planning policy is the ability to protect the individual property owner's right to sufficient access to sunlight to ensure that present and future solar systems are effective.

Solar Zoning Techniques is intended to provide municipal planners and officials with an understanding of the implications of solar access protection for new and existing development. Also provided are practical methods such as determining the "solar envelope" to effectively ensure solar access in low and medium density development.

The focus of the report is on the use of zoning by-laws as a means to protect solar access. While there are other legal tools, such as covenants and easement agreements between individual property owners, these are difficult to establish and maintain and are ineffective for larger areas. Consequently it is generally recognized that the zoning by-law is the best tool currently available for solar access protection.

Solar Envelopes - Low Density

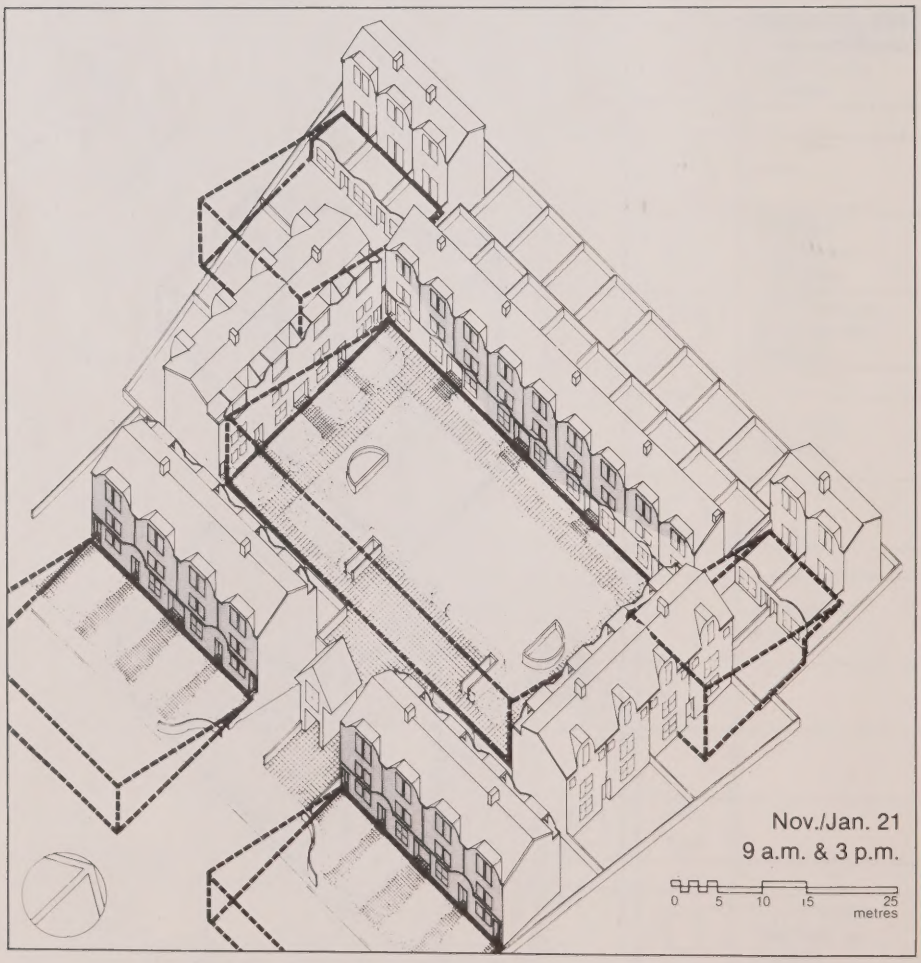


A brief overview of the basics of sun movement and shadowing, current solar space heating technology and the use of a solar zoning by-law is provided in this report.

In summary, the conclusions of this study of solar zoning techniques are as follows:

1. The use of passive solar energy for space heating can be an effective supplement to conventional energy sources in Ontario, particularly in low density residential development. Thus, zoning to protect present and future solar access is an important consideration for both Ontario's energy and land use planning policies.
2. Zoning by-laws to protect solar access can be successfully achieved in most new low density residential developments, and in many existing low density neighbourhoods in Ontario.
3. In Ontario latitudes, solar access zoning for medium density residential development (30-80 units per hectare) produces some constraints on the form and layout of the buildings. The trade-off between the benefits of passive solar gain, and the loss of design amenity must be considered before enacting solar zoning for new medium density development.

Solar Envelopes - Medium Density



Energy and Rural Land Use Planning in Ontario

This study discusses opportunities for the conservation of energy in rural Ontario through the land use planning framework.

The study analyzes rural energy consumption patterns at the municipal level and deals with regional as well as site-specific matters. Due to the diversity which exists in terms of physiography, economic activity and land use patterns, three distinct baseline models have been formulated for the purposes of analyzing energy consumption patterns in rural Ontario. These three models are intended to be representative of township units located in southern, central and northern Ontario with economic and land use orientations to agriculture, recreation (waterfront cottages), and renewable resources (forest harvesting), respectively.

For each base model examined in the study, several alternative land use arrangements, which reflect variations in existing patterns, are formulated, and their effects upon base levels of energy consumption are analyzed. Planning policy considerations which may contribute to the conservation of energy through the modification of land use arrangements are also identified.

The study also contains analyses of on-site, energy-related planning considerations. Particular reference is made to energy-conserving opportunities available through alternative site planning practices, taking into account the unique climatic characteristics of rural areas.

The section of the study pertaining to on-site energy consumption is not test or evaluation-oriented but rather serves to convey information and concepts. A specific section concerned with site planning notes the major climatic variables which affect energy consumption in rural areas. The major climatic variables discussed are the same as those which affect heating requirements in urban areas. Their magnitude and importance, however, differ greatly. Observations and conclusions made concerning the varying importance of such variables from urban to rural situations, point to the need for the development of "rural-specific" site planning practices. The transfer of urban-oriented site planning practices may not be sufficient to mitigate the effects on space heating requirements imposed by rural climatic conditions.

The final section of the study summarizes the observations and conclusions arising from the previous sections. On the basis of these observations and conclusions, this section suggests alternative planning policy and considerations which, if implemented, will lead to the more efficient use of energy in each of the three model situations. Recommendations pertain, in particular, to a municipality's two main planning documents, the Official Plan and Zoning By-law.

Landscape Planning for Energy Efficiency

There is a significant role for landscape planners in planning and design processes. The role of landscape planning in increasing energy efficiency covers two aspects of environmental design: reducing energy consumption in individual buildings and increasing the energy efficiency of the community as a whole.

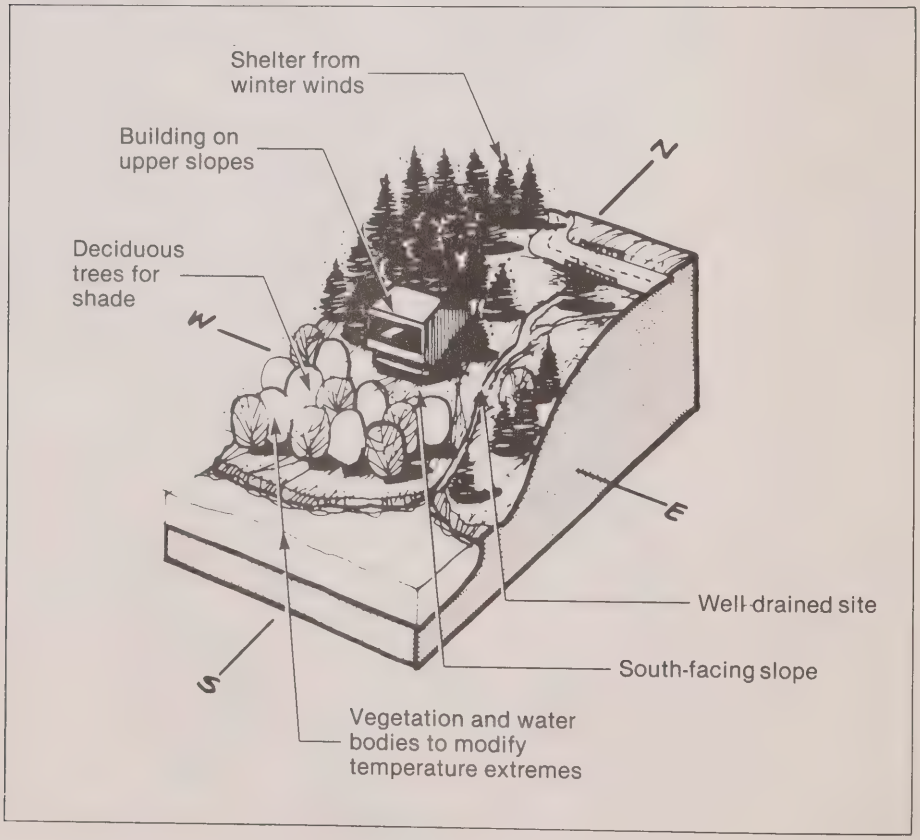
This report is designed to stimulate interest and discussion among professionals and the general public. It summarizes existing research on landscape planning for energy efficiency and indicates those areas where further research is needed. Emphasis is placed on information applicable to the climatic and physical features which are typical of Ontario.

Objectives of the report include:

- An identification of the specific characteristics of Ontario's climate and an analysis of their effects on energy consumption and human comfort.
- An analysis of how the effect of climate factors can be modified by appropriate planning and design.
- An analysis of the costs of landscape planning relative to its benefits.

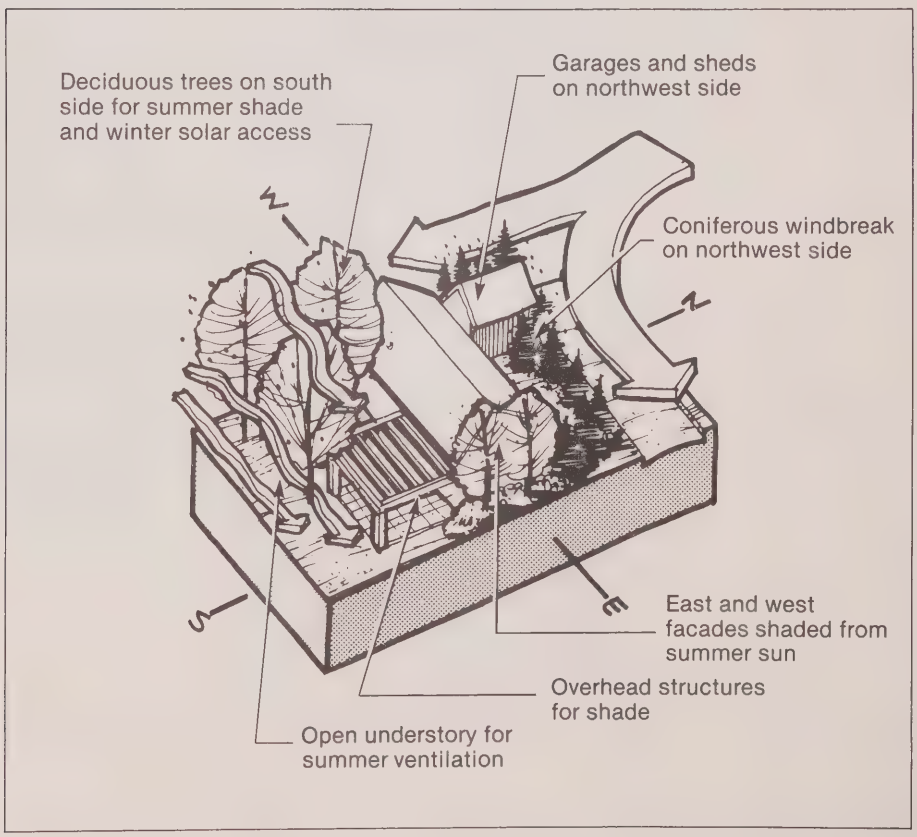
Consideration is given to both urban and rural development and to a range of building functions including residential, commercial, and industrial with emphasis on residential development within urban areas.

Site Selection for Energy Efficiency



Following a short introduction in Part 1, Part 2 discusses those climatic factors which affect energy consumption in Ontario, and describes the basic climatic patterns characterizing the province. Part 3 describes the major natural vegetation types found throughout Ontario, and discusses their potential implications for energy efficient design in various regions. Part 4 illustrates the modification of climatic factors caused by terrain, vegetation, water bodies and urban areas, and describes the methods and techniques currently available for modifying the individual climatic factors. Part 5 further elaborates on the methods and techniques by discussing certain problems and conflicts which arise when combinations of climatic factors are considered together. Emphasis is placed upon the application of climate control methods to a range of building, community, and open space types. In Part 6, the parameters and methods of cost/benefit analysis are examined.

Site Design for Energy Efficiency



Climatic Information for Energy Conscious Planning

Urbanization and technical development have greatly improved the means available to ensure human comfort in the twentieth century. We can now adapt our living and working spaces to maintain a constant temperature and humidity regardless of outdoor conditions. We can measure the degree and intensity of climatic changes (wind, precipitation, heat, cold, and humidity) and thereby estimate the amount of mechanically created energy needed to bring indoor conditions to a comfortable level. Moreover, building planners can take climatic influences into account before construction begins and thus minimize future energy requirements by the placement of the structures with regard to the influences of wind, sunlight and slope.

Climatologists are being asked more and more to work with planning professionals to consider all aspects of climate when planning the built environment. This has become essential in the face of rising energy costs and the eventual depletion of convential fuels. Far-sighted planning is particularly crucial in urban areas where the majority of our convential energy resources are consumed. This report then, is aimed for the most part at urban planners and developers in both the private and public sectors to familiarize them with the data available to ensure energy-efficient urban growth and redevelopment in the future.

Ontario's climate is far from uniform. The northern and southern areas differ greatly. The report shows both the causes of these differences (Arctic winds versus Gulf of Mexico air currents, the Great Lakes, latitude, and sunlight) and provides an explanation of the specialized energy needs of each area in the province.

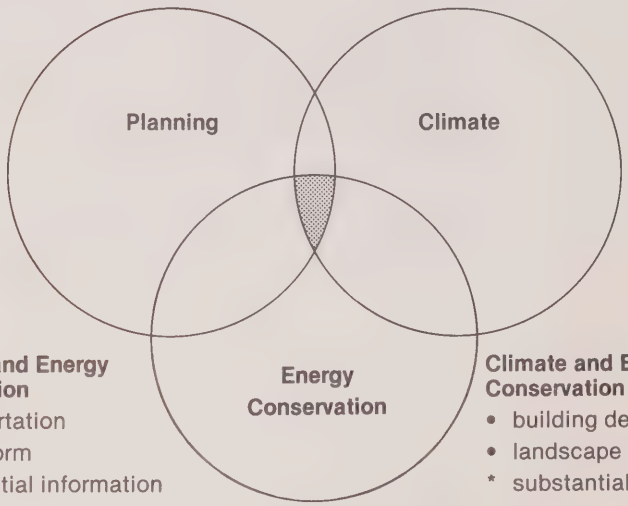
Every conceivable aspect of development has an effect on the climate of an urban area and the comfort of its inhabitants. This report illustrates how tall buildings downwind from smaller ones affect wind velocities and strength and how buildings located in low lying areas where cool air pools, will experience the need for winter heat. It discusses how to maximize the hours of direct sunlight during the heating season through window placement. In examining the effect of green space on the surrounding climate, it corroborates the aesthetically-derived planning practice of including parkland and lawns in urban developments; it examines how ground surface temperature is affected by landscaping, and the important role of evaporation and transpiration in cooling an urban area in the summer. All types of vegetation are examined for their influences – from grassy areas to coniferous forests.

The report provides information about the tools used by climatologists to measure and document the climatic variations in any given area. This equipment and the methods for utilizing it is explained in layman's terms.

Data gathered from a variety of specialized sources have been brought together to provide planners with both the technical and theoretical information on climate and the application of climatic data in planning to reduce energy consumption. Information relating to the three areas of climate, planning, and energy conservation is provided as described in the diagram.

Relationship of Planning, Climate and Energy Conservation

Planning and Climate
- wind in pedestrian areas
- outdoor comfort levels
- parks planning
- limited information



Planning and Energy Conservation
- transportation
- urban form

* substantial information

Climate and Energy Conservation
- building design
- landscape practice

* substantial information

Planning, Climate and Energy Conservation

- solar orientation of buildings
- urban heat islands
- placement of barrier buildings
- locate residential development on south slopes

** very little information

The Community Energy Profile: Concepts, Methods, Applications

The cost of energy and the long-term availability of certain energy forms is the double-barrelled energy problem facing municipalities today. The response to this problem varies from one municipality to the next. Municipal officials, anxious to respond to energy problems, are sometimes hindered by the absence of basic information. The community energy profile is part of the data base that municipal officials could use to help make sound energy management decisions.

The community energy profile is not however, an end in itself. It is part of a larger process of community energy planning and management. A companion document to the **Guide to Community Energy Profiling,** this report provides background information on concepts and methods of community energy profiling, reviews their application in various jurisdictions, and draws out lessons for Ontario municipalities.

Chapter 1 briefly describes the energy problem context for community energy planning and identifies three municipal energy activity patterns. Chapter 2 examines the concepts behind community energy profiling and the alternative approaches to conducting a profile. This chapter also describes five prominent methods that have had a significant influence in the development of community energy profiling.

Chapter 3 provides a summary of the U.S. Department of Energy's Comprehensive Community Energy Management Program (CCEMP) and the findings of the CCEMP evaluation. The final chapter focuses on the conclusions from the CCEMP experience and considers the implications for energy profiling in Ontario communities. General references on profiling and specific examples of community energy profiles, together with the method used in the study, are presented in the appendix.

Guide to Community Energy Profiling

This guide is intended to assist municipal officials preparing community energy profiles. Energy profiling is seen as one element of a community energy management process aimed at reducing dependence on oil, increasing the efficiency of all energy uses, and increasing the contribution of indigenous and renewable resources.

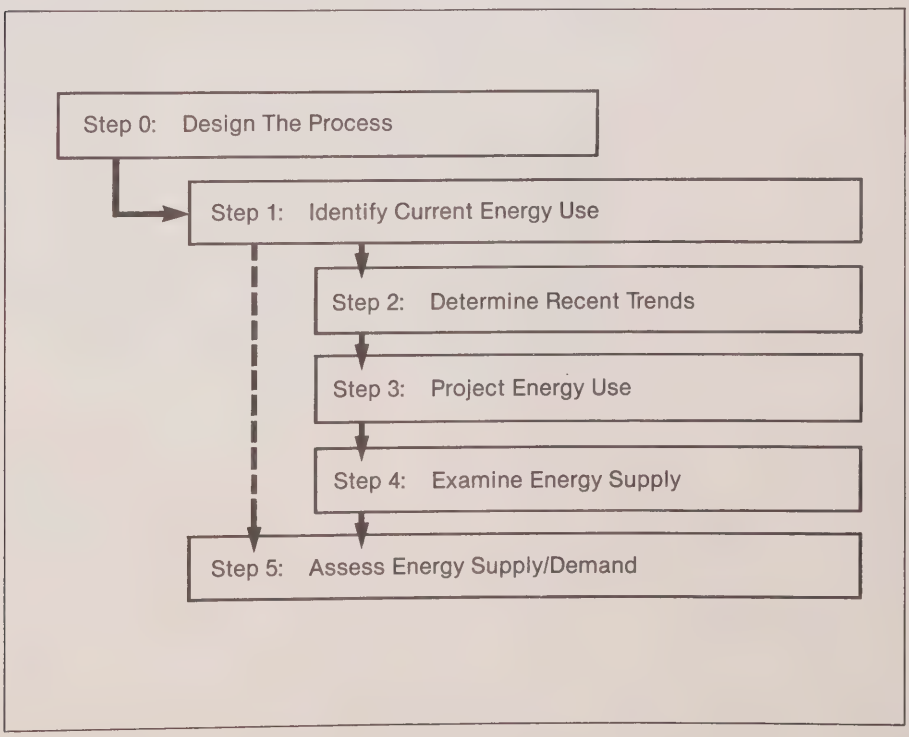
Section 1 provides an overview of the provincial energy problem and policy context. It briefly describes Ontario's current energy situation, including supply and consumption, and presents projections for the future. Ontario's energy policies and targets are summarized and the municipal role in meeting these objectives is outlined.

Section 2 discusses the community energy management context within which community energy profiling occurs. It briefly outlines two main components of the planning process that culminate in a community energy management program plan. The first component, including the community energy profile, emphasizes information; the second, policy/program options, stresses evaluation. Profiling follows an iterative approach that begins with a rough approximation (Round 1 profile) and eventually, after several rounds, may result in a comprehensive data base for community energy management.

Section 3 sets out in detail, a six-step process for conducting a Round 1 community energy profile. The six steps of a Round 1 profile include: 0) the design of the profiling process; 1) an identification of current local energy use; 2) a determination of recent trends in local energy use; 3) the projection of future energy use; 4) an examination of local energy supply; and 5) an assessment of the local energy supply/demand situation (see figure below).

The Appendix provides information on common energy units and conversion factors. References on profiling, examples of community energy profiles and a review of the profiling experience to date are presented in the accompanying volume, **The Community Energy Profile: Concepts, Methods, Applications.**

Steps in a Community Energy Profile



Estimating Energy Consumption for New Development

It is often assumed that some forms of development are inherently more energy-efficient than others, e.g., compact medium-density development vs. sprawl or rural estate development. The travel, servicing and construction energy costs are different for each, yet little documentation exists so far as to the actual energy consumption associated with the various development patterns, and a simple means for estimating the energy use is not available.

The objective of this report is to make available a simple method for estimating the total energy consumption of new residential, commercial, industrial and institutional development.

The basis for the methodology employed throughout the manual is a worksheet which specifies all of the information which the user requires to perform the calculations. The worksheet is set up in a manner which guides the user through the calculations, all of which can be performed on a simple hand calculator.

The basic energy unit in the calculations is the mega-joule, i.e., one million joules. No attempt has been made to convert energy units to cost in dollars.

The manual can be used to compare total energy consumption of different forms of new development and different land use mixes on the same site. It can also assist in targeting important areas for conservation measures. It can not be used as a definitive means of calculating energy use of individual buildings and should not be applied to existing developments, which do not have the energy characteristics of new buildings constructed under current building codes.

There are seven basic worksheets, one each for calculating total annual energy consumption of residential, commercial/institutional, and industrial buildings, one for annual transportation energy use (both public and private), one for annualized energy consumption related to construction of site services, one for the energy consumption of operating municipal services, and one for aggregating the energy consumption total for the project. An example of a residential work sheet is shown here.

A major feature of the manual is the Data Catalogue. This provides the user with both data and detailed guidance in selecting the inputs for the worksheets. The catalogue is divided into seven sections. With the exception of Section B, which provides a methodology to calculate detailed space heating requirements of a particular structure, each section of the catalogue provides all the data and coefficients for one of the worksheets.

Three case studies of typical mixed-use developments in Ontario are evaluated using the worksheets and data catalogue. Each case study includes a complete analysis of two alternative development concepts. The examples include a residential subdivision in a town, a secondary plan in a larger city and a suburban town centre development.

Finally, the study makes a number of recommendations for potential energy savings in new developments, the impacts of which can be analyzed using the methodology developed in this manual.

Worksheet No. 1
Residential Energy Consumption

NO. 2 A

1	Plan Data		Energy Coefficients (MJ/unit/year)				8	9
	2	3	4	5	6	7		
Unit Type	Number of Units	Gross Floor Space (m)	Space Heating	Space Cooling	Water Heating	Lighting and Appliances	Total of Energy Coeffi-cients (MJ/unit /year)	Annual Energy (GJ)
Source	User	User	Table A1	Table A7	Table A8	Table A9	4+5+6+7	2 x 8 – 1000
SFLS	87	197	213,000 +	9600 +	24,100 +	21,000	267,700	23,290
SFR	200	116	136,200 +	9600 +	24,100 +	21,000	190,900	38,180
SFSL	200	130	149,700 +	9600 +	24,100 +	21,000	204,400	40,880
SFTS	200	124	136,100 +	9600 +	24,100 +	21,000	190,800	38,160
SD	364	124	125,400 +	7700 +	25,400 +	21,000	179,500	65,338
RH	48	119	100,900 +	7700 +	17,500 +	21,000	147,100	7,061
Other			+	+	+			
			+	+	+			
			+	+	+			
			+	+	+			
ALR			+	+	+			
AHR			+	+	+			
Other			+	+	+			
			+	+	+			
			+	+	+			
			+	+	+			
			+	+	+			
Total Units	1099	11						

SFLS - Single Family L-Shaped
SFR - Single Family Regular
SFSL - Single Family Split Level
SFTS - Single Family Two Storey
SD - Semi-detached
RH - Row House
ALR - Apartments Low Rise
AHR - Apartments High Rise

10 Total Annual Residential Energy Consumption = (sum of Items in Column 9) (GJ/Year) — 212,909

Enter in Column 3 of Worksheet No. 7

12 Residential Energy Consumption Indicator = 10 – 11 GJ/unit/year — 194

Enter in Column 6 of Worksheet No. 7

Alternate Energy Supplies and Technologies and Their Implications on Land Use Planning

This report takes an in-depth look at various energy systems. It concludes that conventional energy systems such as coal-fired generating plants and electric transmission facilities are less efficient than alternate technology and systems – specifically cogeneration and district heating – and explains how these alternate systems work.

Both the cogeneration and the district heating systems discussed in this report draw their greatest strength from their ability to productively and, thus efficiently, use energy that would otherwise be wasted. Cogeneration means the generation of electricity and thermal power from one basic source of energy. The thermal energy can be used as dry heat for an industrial process or be converted into steam or hot water. Such a dual-purpose process can improve the efficiency of the energy utilization from about 30 per cent to 85 per cent. The planner is introduced to three principal approaches to cogeneration in this report: central utility plant cogeneration, industrial plant cogeneration and total energy with cogeneration.

District heating is the use of one or more centralized sources of heat to supply thermal energy to a group of buildings. This system has potential because it can use heat generated by industry to heat hospitals, apartment complexes, and other areas of the community which might not be economically served on their own. All groups of buildings under a single ownership are prime candidates for such a system.

The final pages of the report look specifically at the land use planning issues and principles involved in the energy-efficient proposals discussed in detail in the earlier part of the work. These principles are essential to the viability of the energy proposals. They must work hand-in-hand. Some of these include: contiguous, centralized development; medium and high density residential development; proximity between home and routine services required outside the home; public transit; foodlands preservation.

Other Publications

The Ontario Ministry of Energy has published several volumes on various aspects of energy conservation and land use planning.

The following publications are available from the Government of Ontario Bookstore, 880 Bay Street, Toronto, Ontario, M5S 1Z8, (416) 965-6015

Energy Conservation Opportunities for Municipalities
1978, Free

Energy Efficient Community Planning: Bibliography
1980, $2.00

Energy Efficiency in Municipalities: The Law
1980, Free

Energy Efficient Community Planning: Seminar Proceedings
1980, $2.00

New Directions in Municipal Energy Conservation:
The California Experience
1980, $3.00
Executive Summary (free)

Subdivisions and Sun:
Three Design Studies
1980, $4.00
Executive Summary (free)

Mississauga City Centre Energy Study
1981, $5.00

Energy Conservation Opportunities for Downtown Projects:
The Brantford Case
1982, $3.50

Sun Shadow Guide
1982, $2.50

The following publications are available from the Energy Conservation Branch, Ontario Ministry of Energy, 56 Wellesley Street West, 10th Floor, Toronto, Ontario M7A 2B7, (416) 965-0958

Energy Implications of Suburban Intensification (1980)

Community Energy Management: Seminar Proceedings (1981)

City of Woodstock Energy Policy Development Study (1982)

NOTES

Copies available, at $3.00 per copy, payable in advance, from the Ontario Government Bookstore, 880 Bay St., Toronto, for personal shopping. Out-of-town customers write to Publications Services Section, 5th Floor, 880 Bay St., Toronto, Ont., M7A 1N8. Tel: 965-6015. Toll free long distance 1-800-268-7540; in Northwestern Ontario, 0-Zenith 67200. MASTERCARD and VISA accepted.

Ministry
of
Energy

Honourable
Philip Andrewes
Minister